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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09 782,441	02 13 2001	Wing-Cheong Gilbert Lai	303.261US2	9969

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EXAMINER

QUACH, TUAN N

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 06 20 2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/782,441

Applicant(s)

LAI ET AL

Examiner

Tuan Quach

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10 December 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 10-16 and 37-58 is/are pending in the application.
- 4a) Of the above claim(s) 10-12, 37-41, and 49-51 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 13-16 and 42-48 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 February 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Claims 13-16 and 42-48 are elected.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 13, 15, and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice et al. taken with Mikoshiba et al.

Fiordalice et al.¹⁰⁷² teaches forming first CVD titanium nitride layer 22, second CVD titanium nitride layer 24, aluminum layer 26 by CVD. The use of ti-containing precursor and of nitrogen and ammonia is also disclosed. The flowing of nitrogen simultaneously with the flowing of the titanium containing precursor would have been obvious given the deposition containing both components as delineated. See Figs. 2-6, column 2 line 60 to column 4 line 38. The use of nitrogen trifluoride as alternative nitrogen material is

well known and as such would have been obvious. The use of the conductive layers 22/24/26 by patterning to form interconnect is also taught. Fiordalice et al. lacks anticipation primarily in that the various forms of precursors of aluminum are not explicitly recited.

Mikoshiba et al. (5,328,873) teaches CVD of aluminum using various Al precursors, including TIBA, TMA, DMAH, MMAH. See the abstract, column 2 line 39 et seq., column 5 line 25 to column 8 line 55, column 9 line 50-64.

It would have been obvious to one skilled in the art in practicing the Fiordalice et al. process to have employed conventional aluminum precursors to form the aluminum layer since such aluminum deposition using such conventional aluminum precursors is well known in the art as evidenced by Mikoshiba et al. to obtain aluminum of good quality as taught by Mikoshiba et al. Official notice is given regarding any aluminum precursors enumerated in the claims that are not recited in Mikoshiba et al. and the interchangeability of suitable and conventional aluminum precursors would have been obvious.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice et al. taken with Mikoshiba et al. as applied to claims 13, 15, and 16 above, and further in view of Matsumoto et al.

Fiordalice et al. and Mikoshiba et al. are applied as above and do not recite the limitation regarding the silicide layer on the semiconductor structure prior to the step of flowing the first titanium containing precursor.

Matsumoto et al. teaches a method of manufacturing contact structure using barrier metal comprising forming silicide layer 5 on silicon substrate 1 followed by formation of titanium nitride layer 6 and 7 and aluminum layer 8. See Fig. 1, column 2 lines 30-64, Fig. 4, column 3 lines 25-58.

It would have been obvious to one skilled in the art in practicing the above process to have included the silicide layer under the titanium nitride layers and the aluminum layer since such inclusion is conventional as evidenced by Matsumoto et al. wherein such silicide layer is advantageous to form contacts having reduced resistivity.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice taken with Mikoshiba as applied to claims 13, 15, and 16 above, and further in view of Sandhu or Sandhu et al.

The references as applied above do not recite the various alternative forms of titanium-containing precursors in claim 15.

Sandhu teaches the various titanium-containing precursors to form titanium nitride including tetrakisdimethylamido titanium. See the abstract, column 3 line 33-63.

Sandhu et al. teaches the various titanium-containing precursors to form titanium nitride including any suitable metal organic titanium compounds can be employed as well. See column 3 line 28 to column 4 line 68.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the above process to have employed conventional titanium-containing precursors for the formation of titanium nitride including those enumerated as evidenced by Sandhu or Sandhu et al. and wherein the interchangeability of suitable

conventional Ti-containing precursors would have been obvious and would have been within the purview of one skilled in the art.

Claims 42-45, 47, and 48 are are rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice et al. taken with Mikoshiba et al. and Chen et al. or Nulman.

Fiordalice et al. teaches forming first CVD titanium nitride layer 22, second CVD titanium nitride layer 24, aluminum layer 26 by CVD. The use of ti-containing precursor and of nitrogen and ammonia is also disclosed. The flowing of nitrogen simultaneously with the flowing of the titanium containing precursor would have been obvious given the deposition containing both components as delineated. See Figs. 2-6, column 2 line 60 to column 4 line 38. The use of nitrogen trifluoride as alternative nitrogen material is well known and as such would have been obvious. The use of the conductive layers 22/24/26 by patterning to form interconnect is also taught. Fiordalice et al. lacks anticipation primarily in that the various forms of precursors of aluminum are not explicitly recited.

Mikoshiba et al. (5,328,873) teaches CVD of aluminum using various Al precursors, including TIBA, TMA, DMAH, MMAH, See the abstract, column 2 line 39 et seq., column 5 line 25 to column 8 line 55, column 9 line 50-64.

It would have been obvious to one skilled in the art in practicing the Fiordalice et al. process to have employed conventional aluminum precursors to form the aluminum layer since such aluminum deposition using such conventional aluminum precursors is well known in the art as evidenced by Mikoshiba et al. to obtain aluminum of good

quality as taught by Mikoshiba et al. Official notice is given regarding any aluminum precursor enumerated in the claim that are not recited in Mikoshiba et al. and the interchangeability of suitable and conventional aluminum precursors would have been obvious.

The selection of aluminum having small grain size would have been obvious and advantageous as delineated in Chen et al. wherein the aluminum having very small grain sizes tend to minimize grain size growth at later stages, provide good filling of via, and good electromigration characteristics and less tendency to block off the via before it filled as delineated in Chen et al., the abstract, column 3 line 38 to column 4 line 21, column 5 lines 39-48. Such selection would also have been obvious given the teachings of Nulman column 2 line 42-57, column 3 lines 28 et seq, column 6 line 37 to column 7 line 21 wherein the formation of small grain size corresponds to better electromigration resistance, stress resistance and good line definition due to the small grain size.

Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice et al. taken with Mikoshiba et al. and Chen et al. or Nulman as applied to claims 42-25, 47, and 48 above, and further in view of Matsumoto.

Fiordalice et al., Mikoshiba et al., Chen et al., and Nulman are applied as above and do not recite the limitation regarding the silicide layer on the semiconductor structure prior to the step of flowing the first titanium containing precursor.

Matsumoto et al. teaches a method of manufacturing contact structure using barrier metal comprising forming silicide layer 5 on silicon substrate 1 followed by

formation of titanium nitride layer 6 and 7 and aluminum layer 8. See Fig. 1, column 2 lines 30-64, Fig. 4, column 3 lines 25-58.

It would have been obvious to one skilled in the art in practicing the above process to have included the silicide layer under the titanium nitride layers and the aluminum layer since such inclusion is conventional as evidenced by Matsumoto et al. wherein such silicide layer is advantageous to form contacts having reduced resistivity.

Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice et al. taken with Mikoshiba et al. and Chen et al. or Nulman as applied to claims 42-45, 47, and 48 above, and further in view of Sandhu or Sandhu et al.

The references as applied above do not recite the various alternative forms of Ti-containing precursors in claim 47.

Sandhu teaches the various titanium-containing precursors to form titanium nitride including tetrakisdimethylamido titanium. See the abstract, column 3 line 33-63.

Sandhu et al. teaches the various titanium-containing precursors to form titanium nitride including any suitable metal organic titanium compounds can be employed as well. See column 3 line 28 to column 4 line 68.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the above process to have employed conventional titanium-containing precursors for the formation of titanium nitride including those enumerated as evidenced by Sandhu or Sandhu et al. and wherein the interchangeability of suitable conventional Ti-containing precursors would have been obvious and would have been within the purview of one skilled in the art.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is 703-308-1096. The examiner can normally be reached on M - F from 9 to 5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Wael Fahmy can be reached on (703) 308-4918. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9318 (Before Final) and (703) 872-9319 (After Final).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

A handwritten signature in black ink, appearing to be 'Th' or similar, located in the lower right quadrant of the page.